Appendix G

New Technology for Improving System Capacity

The major purpose of the Research, Engineering, and Development (R,E&D) program is to develop and exploit technologies in an effort to increase system capacity and fully utilize capacity resources, accommodate user-preferred flight trajectories, increase user involvement in air traffic management decision-making, and develop air traffic control and aircraft systems that enhance overall safety at the increased levels of operations forecast for the 21st century.

Major FY91-92 Accomplishments

- Federal Aviation Order 7110.110 governing dependent converging instrument approaches using Converging Runway Display Aid (CRDA) was signed November 30, 1992.
- Airport Movement Area Safety System (AMASS) testing started at San Francisco International.
- Independent simultaneous approaches to parallel runways spaced between 3,400 and 4,300 feet were approved when Precision Runway Monitor (PRM) is used.
- The first Traffic Alert and Collision Avoidance System (TCAS) II equipment was certified.
- The Vertiport Design Guide and Advisory Circular was issued.
- Aircraft Situation Displays (ASD) were installed at 20 Air Route Traffic Control Centers (ARTCCs) and selected Terminal Radar Approach Control (TRACON) facilities.
- Dynamic Ocean Tracking System (DOTS) Track Generation and Traffic Display Functions were installed at Oakland, Anchorage, and New York ARTCCs.
- The Runway Incursion Plan was issued.
- ICAO guidance material for reducing vertical separation between FL290 and FL410 to 1,000 feet was completed.
- Eleven Airport Capacity Design Team Studies were completed; six are still underway. Seven Airspace Analysis Technical Reports were completed along with two Airspace Design Team Reports. Four Airspace Studies were initiated.
- Automated En Route Air Traffic Control (AERA), Traffic Management Advisor (TMA), and Traffic Management System (TMS) were integrated into the Integration and Interaction Laboratory (I-Lab).
- The first publicly available versions of SIMMOD for the workstation and PC were issued.

Complete project details, including funding and implementation dates where appropriate, are given in the following pages. Key elements of the R,E&D capacity effort are:

- ATC Technology Program - To enhance the operational capabilities of the air traffic control system through the aggressive introduction of automation. Such projects include Advanced Traffic Management System, Oceanic Display and Planning System, Dynamic Ocean Tracking System, Automatic Dependent Surveillance, AERA, Terminal ATC Automation, Airport Surface Traffic Automation, Airport Movement Safety System, Airport Capacity Improvements, and Wake Vortex Avoidance/Advisory System.
- Aircraft Technology Program - To develop aircraft technologies to enhance ATC capacity and efficiency by enabling aircraft to safely assume some aspects of the air traffic controller's current responsibilities for ensuring aircraft separation and to develop operational procedures and certification criteria to exploit the capabilities of rotorcraft and tiltrotor aircraft. The projects in this program are Traffic Alert and Collision Avoidance System, Cockpit Display of Traffic Information, and Vertical Flight Operations and Certification.
- Future Systems Engineering Program - To develop and maintain the necessary steps required for successful integration of the new and proposed subsystems into the evolving ATC system. This program includes Future System Definition, Flight Operations and ATM Integration, Separation Standards, Integrated Traffic Flow Management, and NAS System Operational Concepts.
- Capacity Planning - To develop technological (other than ATC), procedural, and airport design alternatives which will increase the operational capacity of the system. These projects include airport design, airspace design, and approach procedures.
- Modeling and Simulation Program - To develop tools to plan and implement the Capacity and ATC Technology Program, to develop new facilities to realistically simulate the operation of future air traffic control systems, to develop new models and research techniques to analyze, assess impacts, and guide the long-term technological evolution of the National Airspace System, and to integrate the major pieces of the system so that they play in harmony with one another. The projects include the National Simulation Capability, Operational Traffic Flow Planning, Traffic Models and Evaluation Tools, and Airports and Airspace Impacts Assessments.

The projects described above are explained in detail in the following section. They are divided into four categories: *Terminal Airspace Capacity Related Projects, Other Capacity Related Projects, En Route Capacity Related Projects, and Airport Capacity Related Projects.*

G.1 Terminal Airspace Capacity Related Projects

G.1.1 Terminal Radar (ASR) Replacement Program

Responsible Division: ANR-200
Contact Person: Gerald Taylor, 202/606-4622

Purpose

To provide economical radar service at airports with air traffic densities high enough to justify the service and upgrade the highest density airports with the latest state-of-the-art equipment.

ASR-4/5/6 radars need to be replaced because of the decreasing availability of spare parts and the high-maintenance workload. Furthermore, repair parts for the ASR-4/5/6 radars are in short supply. A total of 96 ASR-4/5/6 radars are being replaced. Of these, 40 ASR-4/5/6 sites are being upgraded to ASR-9's, 40 ASR-4/5/6's are being upgraded to ASR-8's, and 16 ASR-4/5/6's are being upgraded to ASR-7's, a procedure called "leapfrogging."

Program Milestones

The first ASR-9 Operational Readiness Demonstration (ORD) was in FY89 and the first leapfrog ORD was in FY90. The last leapfrog ORD is scheduled for FY94 and the last ASR-9 ORD is planned for FY95.

Products

- Replace 96 radars
- Leapfrog 56 radars

G.1.2 Los Angeles Basin Consolidation

Responsible Division: ANS-300
Contact Persons: Frank McArthur, 202/267-8680
Bill Henshaw, FTS/984-0220

Purpose

To consolidate five Los Angeles Basin Terminal Radar Approach Control Facilities (TRACONs) to be known as the Southern California TRACON. This new facility will enhance traffic management in Southern California and allow more efficient use of the airspace.

The Los Angeles Basin is created by the Pacific Ocean and the San Rafael, Sierra Madre, Techachapi, San Gabriel, San Bernardino, San Jacinto, and Santa Ana Mountain ranges. The basin area is approximately 75 miles wide and 100 miles long. The major portion of this airspace below 10,000 feet is currently controlled by TRACON facilities located at Los Angeles, Burbank, El Toro (coast), Ontario, and San Diego. These five TRACON facilities provide instrument flight rule services for 29 airports within their respective areas of jurisdiction. This includes eight major air carrier airports and five military air fields. Instrument operations in Southern California have increased greatly over the last two years. Forecasts call for well over 3,000,000 operations by the year 2000.

Products

This consolidation will enhance safety, improve airspace utilization, and provide an IFR air traffic control system approach for the major hub and satellite reliever airports in Southern California.

- Start site adaptation 01/90
- Building contract award (completed)................ 09/91
- Building occupancy date 02/93
- Los Angeles TRACON consolidated 12/93
- Coast TRACON consolidated 05/94
- Burbank TRACON consolidated........................ 10/94
- Ontario TRACON consolidated 04/95
- San Diego TRACON consolidated 09/95
- Project completed 02/96

G.1.3 Simulation Model Development (SIMMOD)

Responsible Division: AOR-200
Contact Person: Steve Bradford, 202/267-8519

Purpose

To provide an accurate, comprehensive, and cost-effective analytical tool for evaluating proposed improvements to the national airspace system.

This capability will provide quantitative analyses to determine the impact of proposed changes to airports, airspace, and aircraft. The FAA Airport and Airspace Simulation Model (SIMMOD) will play a significant role in future development of the national airspace system by reliably identifying the most appropriate airport and airspace design and procedural alternatives.

SIMMOD will be enhanced with logic improvements that will increase realism in simulating the actual behavior of the air traffic control system and air operations. The cost of extensive data preparation will be reduced by developing automated data-acquisition hardware and software. Visual replay of scenarios will continue to be developed as an effective quality-control technique and for specific site calibration. Full documentation of the model's algorithms has been provided, as well as training manuals and courses, so that the model may be widely used by the FAA and others to improve designs and procedures in the airspace system.

Program Milestones

Version 1.0 of SIMMOD was validated in FY88 and publicly released in FY89. Through FY90, SIMMOD has been applied to numerous airspace design tasks at Los Angeles, Boston, Dallas-Ft. Worth, Denver, Chicago, Kansas City, Houston-Austin, New York (Phase I), and Miami. Studies that focused on airport design and ground operations during this period include San Diego, Salt Lake City, Portland, Milwaukee-Mitchell, and Minneapolis-St. Paul. SIMMOD was used outside the United States for airport and airspace capacity studies at Madrid, Majorca, Quebec, Toronto, Ottawa, Hong Kong, Sydney and Melbourne.

In FY91, SIMMOD continued to be used for major airspace capacity and design studies at Cleveland, Washington, New York (Phase II), Oakland, Jacksonville, and Atlanta. The model has been purchased by 145 organizations, many of which are applying the model in numerous locations for airline, airport, and government agencies.

For FY92, applications work continued for both airport and airspace environments. In addition, Version 2.0 of SIMMOD was completed. This version, available for workstations, is significantly faster than that for microcomputers. This version includes better graphical output displays and automated data-acquisition capability. For example, SIMMOD generates output data that can be used directly by other FAA models, including the Integrated Noise Model used for environmental studies.

For FY93, the 3-dimensional version of SIMMOD will be completed and distributed to users. This version will significantly improve the ability of analysts and decision makers to design airspace changes by allowing full visualization of traffic iterations in all dimensions. Facilities for the display of enhanced geographical and census data will be included and will provide the analyst with deeper insight into potential noise conflicts arising from redesigning airspace for capacity improvement.

Products

- Complete computer program for workstations and microcomputers
- An organization of users throughout the FAA and industry
- Training sessions, manuals, and technical documentation for users

G.1.4 Terminal ATC Automation (TATCA)

Responsible Division: ARD-40
Contact Person: Peter Challan, 202/267-7335

Purpose

To develop automation aids to assist air traffic controllers and supervisors in overcoming the limitations of the terminal area air traffic management process, providing advisories designed to optimize the flow of arrival traffic and to facilitate the early implementation of these aids at busy airports.

The TATCA program consists of three projects developed in parallel to assist air traffic controllers. These projects are: the Converging Runway Display Aid (CRDA), the Center-TRACON Automation System (CTAS) and the Controller Automation Spacing Aid (CASA). CRDA provides geometric spacing aids for aircraft by means of software changes within existing ARTS terminal radar processors. A Federal Aviation Order (7110.110) governing dependent converging instrument approaches utilizing CRDA was signed November 30, 1992.

The CTAS project is now in laboratory development and consists of the following components: a comprehensive traffic planning and scheduling tool known as the Traffic Management Advisor (TMA) for the Air Route Traffic Control Center (ARTCC), a Descent Advisor (DA) for en route controllers, a turn and speed advisor for terminal controllers known as the Final Approach Spacing Tool (FAST) and an ascent trajectory synthesis tool for departing aircraft known as Expedite Departure Path (EDP).

Longer term TATCA activities focus on fully developed terminal automation techniques integrated with other ATC and cockpit automation capabilities of the Advanced Automation System (AAS) and other ATC and cockpit automation capabilities.

Program Milestones

Laboratory evaluations and demonstrations of TMA have been completed. TMA is currently being evaluated and demonstrated in the Denver ARTCC. Further field evaluation for TMA and FAST will take place at the Dallas/Fort Worth Center in FY93. Laboratory development of DA and EDP is continuing.

Products

- Major CRDA milestones include:
  Begin national implementation 07/92
- Major TMA milestones include:
  Field Concept Development and Evaluation .. 08/92
  Limited National Deployment....................... 10/94
- FAST milestones include:
  Fast Functionality in FDADS 08/92
  Field Concept Development/Evaluation 05/93
  Begin Limited National Deployment............. 04/95
- DA milestones include:
  Develop Prototype Software 07/93
  Deploy DA in ISSS 04/95
  Develop DA in ACCC 04/98
- EDP milestones include:
  Begin Limited National Deployment............. 04/96
- CASA milestones include:
  Begin Limited National Deployment............. 06/95
- TATCA/AAS milestones include:
  Modification to the System Level
  Specification for the AAS 04/94
  Integrated TATCA with ACCC 04/94

G.1.5 Airport Surface Traffic Automation (ASTA)

Responsible Division: ARD-50
Contact Person: John Heurtley, 202/646-5566

Purpose

To develop airport surface surveillance, communications, and automation techniques that will provide an effective runway incursion prevention capability.

To provide departure traffic management to sequence aircraft to the departure end of the runway according to schedules designed to expedite traffic flow and increase the capacity of the airport surface in all weather conditions.

To provide a linkage of information between terminal air traffic control automation tools.

The ASTA program consists of five elements: a runway status light system, a surveillance data link, aural and visual warnings, data tags, and a traffic planner.

The Runway Status Light System (RSLS) will automatically control lights that show pilots if the runway is occupied. ASTA will provide new surveillance data and interface software to enable the RSLS to function with ASDE-3 sensors, AMASS, and ARTS. For the surveillance data link, ASTA will combine surveillance information from ASDE-3 radars and Differential GPS. ASTA will provide controllers with prioritized aural and visual warnings and cautions on ARTS equipment. ASTA will also display target locations with alphanumeric data tags. ASTA will provide positive target identification for special vehicles such as fire, rescue, snow plows, etc. The ASTA project will share information with the TATCA project to create an interrelated runway incursion prevention system.

All airports that are slated to receive ASDE-3/AMASS equipment under the F&E program will also receive ASTA. For those airports not equipped with ASDE-3/AMASS, ASTA will use other potential ground movement sensors, such as the DGPS surveillance data link for detecting aircraft and vehicles.

Program Milestones

The ASTA project was started in FY89 to reduce the risk of runway incursions and improve airport capacity through increased efficiency of aircraft surface movements and better departure traffic management. In FY90, alternative capabilities for reducing runway incursions were identified. In FY93, contracts were awarded to demonstrate alternative technologies to prevent runway incursions, the third AMASS was established at Boston Logan International Airport to provide an ASTA DGPS testbed, and the RSLS was successfully demonstrated to industry at Boston Logan.

In FY94, technical performance assessments on the surveillance data link and associated ground processing functions will be completed at Boston Logan. In FY95, a detailed system specification for incorporating DGPS data with ASDE-3/AMASS and aircraft/vehicle data tags will be completed. In FY96, an RFP for developing a pre-production unit and 40 to 60 production units will be released and the following year the contract will be awarded and operational test and evaluation will take place.

G.1.6 TCAS II Applications to Improve Capacity

Responsible Division: ASC-200
Contact Person: Ken Peppard, 202/267-7375

Purpose

To identify and evaluate potential applications of the Cockpit Display of Traffic Information (CDTI) provided by the Traffic Alert and Collision Avoidance System (TCAS) for improving the efficiency, capacity, and safety of aircraft operations.

To determine which applications are worthwhile and develop the standards and procedures required for their operational implementation.

CDTI has the potential to increase the efficiency and capacity of the National Airspace System (NAS), reduce controller workload, and, at the same time, increase the level of safety. With the advent of TCAS, pilots will have an electronic display of nearby traffic in the cockpit.

A user group consisting of air carrier pilots, general aviation pilots, and air traffic controllers has been convened to identify and prioritize potential CDTI applications. The most promising of these applications will be evaluated by a combination of analysis, fast-time and real-time person-in-the-loop ATC simulations, using both part-task and full-task cockpit simulators and flight tests. Consideration will be given both to applications that can use the TCAS display "as is" and ones that require additional information and enhanced display capability. For each studied application, procedures will be developed with due consideration given to all relevant pilot and controller issues, such as workload and safety, and any special data and/or display requirements will be defined.

Program Milestones and Products

- Identification of near-term CDTI applications 5/93
- ATC simulations with full-task simulators 6/93
- Proposed procedures for near-term applications 12/93
- Display requirements for near-term applications 12/93
- Identification of long-term CDTI applications ... 07/94
- Flight tests 12/94
- Display and other requirements of long-term CDTI applications 06/95
- Implementation of long-term CDTI applications 01/97

G.2 Other Capacity Related Projects

G.2.1 FAA National Simulation Capability (NSC)

Responsible Division: AOR-20
Contact Person: Randall J. Stevens, 202/267-7056

Purpose

To establish the NSC to assess proposed future subsystems, aviation procedures, airspace organization, and human factors in an integrated fashion to determine the definition of the 21st century NAS.

The NSC will provide a means of analyzing and experimenting with alternative concepts for potential NAS development, as well as a capability for hands-on development of prototype configurations for future NAS integration. This will enable improved assessment of new concepts and high-level system design, new technologies, system requirements, potential problems, and issues. Resulting requirements specifications for procuring NAS equipment will be more accurate, complete and achievable. The initial effort has been to establish the Integration and Interaction Laboratory (I-Lab) as a proof-of-concept.

The NSC will feature rapid prototyping, configuration, modularity, flexibility, and expandability to address research, engineering, and development ATC issues and provide feedback to interacting programs. Initial NSC capabilities will be derived from the I-Lab. This base was expanded through FY92 to support the conduct of human-in-the-loop simulations of the future En route, Terminal, and Traffic Flow Automation. The functionality will be extended in FY93 to incorporate human-in-the-loop inter-operability simulations adding oceanic and an interface with applicable weather dissemination subsystems. Applicable TCAS enhancements, such as using TCAS for flight-following, will also be incorporated. Results will provide tangible support for operational suitability and the efficacy of proposed future enhancements within the NAS.

Program Milestones

In FY90, the FAA initiated the I-Lab Project. Initial development included facility preparation, commercial equipment and software procurement, and software infrastructure development. FY90 activities culminated in an illustration of technical feasibility by creating an integrated, interactive simulation encompassing six existing prototypes. The illustration supported arrival and departure control within the New York Metroplex.

During FY91, the I-Lab completed the integration of initial hardware (common console and cockpit mockups) and commercial off-the-shelf software procurements. Development activities included addition of prototypes and simulations of AERA services (en route automation) and components of the Center TRACON Automation System (CTAS). In FY92, the I-Lab completed establishment of its initial experimentation capability including central simulation control. This extended the concepts illustrated in the proof-of-concept and provide the capability to conduct experimentation with operational personnel. The initial experiments will assess alternatives for interaction between traffic flow management and controller automation aids in the en route and terminal airspace. Detailed NSC planning will continue.

The NSC is expected to begin operation in FY93 using the resources of the I-Lab and the FAA's Technical Center.

Products

- Operational I-Lab/NSC experimentation capability to support assessments of interaction and inter-operability among ATC (including aircraft) automation elements and human-in-the-loop performance
- Simulation results from alternative configurations of proposed future systems

G.2.2 Dynamic Special-Use Airspace Management

Responsible Division: ARD-100
Contact Person: Barry Gamblin, 202/267-9855

Purpose

To develop automation capabilities and operational requirements for enhancing the ability of FAA and DoD to dynamically coordinate the use of military Special Use Airspace (SUA).

The current manual methods for coordinating the use of military SUA between FAA and DoD operational entities do not allow for the timely exchange of information, thereby limiting the ability of the FAA to efficiently manage the NAS airspace or to incorporate that coordination information into real-time ATC flow management decision-making. New ATC procedures and the operational requirements for the associated technologies will be developed to enable the dynamic coordination of military SUA.

Program Milestones

Interagency procedures were examined in FY89 to identify and document the current methods for the FAA/DoD coordination of military SUA. During FY90, additional discussions between FAA and DoD were conducted to determine the general development direction the agencies should pursue to enhance that coordination process. In FY91, an effort was initiated to develop an "end-state" concept of a Dynamic Special Use Airspace system that would interface with the DoD SUA scheduling organizations to satisfy the requirements of the FAA's ATC mission. Those ATC requirements are: the timely exchange of military SUA scheduling information and a direct interface with the FAA Traffic Management System.

In FY92, software/hardware enhancements were incorporated into the existing SUA Management System (SAMS) to reduce the time and workload associated with processing SUA data provided by FAA field elements.

Products

- SAMS functionality incorporated into TMS
- Direct interface to military SUA planning and coordination system
- Enhanced FAA/Military Liaison Specialist automation capabilities
- Direct interface to automated FSS's relating to SUA status

G.2.3 National Airspace System Performance Analysis Capability (NASPAC)

Responsible Division: AOR-200
Contact Person: Steven Bradford, 202/267-8519

Purpose

To maintain a long-term analysis capability through the application of modern tools of operations research and computer modeling and to aid in developing, designing, and managing the nation's airspace on a system-wide level.

This capability allows analysts to identify limiting factors in national airspace system performance and provides quantitative analyses to determine the impacts of proposed changes on the overall aviation system, while offering useful information to decision makers and strategic planners.

The principal tool used in the project is a simulation model of the entire national airspace system. The model simulates the movement of individual aircraft through the nationwide network of airports, en route sectors, routes, navigation fixes, and flow control restrictions. The model permits the analyst to capture the effects of system performance problems, usually measured in terms of delays, as they propagate throughout the nation during the day. The representation of the national airspace system reflects the effects of instrument meteorological conditions at airports, air traffic control procedures, air carrier operating practices, and additional details.

Products

Several analyses were completed recently using the NASPAC Simulation Modeling System (SMS) to assess the implications of proposed system improvements on NAS performance. These analyses included studies of the nationwide impacts of the potential failure of an Area Control Facility under alternative facility consolidation assumptions, the implementation of Microwave Landing Systems (MLSs) at New York and Chicago, the implementation of Precision Runway Monitors (PRMs) at selected airports, the implementation of civil tiltrotor service in the Northeast corridor , the impact of rotating the arrival fix cornerposts at Chicago, the impact of the Dallas/Ft. Worth Metroplex Plan, and the impact of communications outages.

The results from these efforts have aided in assessing likely impacts and in formulating FAA positions on proposed improvements. Follow-on efforts from a subset of these analyses will investigate additional issues that have surfaced more recently or that have been identified as part of the analyses performed to date.

Program Milestones

A number of significant enhancements have been made to the SMS recently. An additional module of the SMS was developed that calculates user cost impacts based on delay data estimated by the simulation model. A new release of the NASPAC SMS, Release 3, was delivered to the FAA in June of 1992. The enhancements incorporated in Release 3 of the SMS are designed to reduce the time required to complete model applications, to make the model easier to use, and to expand the range of applications in which it can be used effectively. The principal enhancements included in Release 3 include a capacity tool to make it easier to develop the airport capacity values used as input to the model, a tool to assist analysts in developing demand estimates for new air carrier hubs or new airports, enhancements to the user interface and data file structures and tools to assist analysts in processing results produced by the model.

In FY92, several other tasks were conducted that address concerns related to aviation system capacity. Work began on efforts to improve the level of support provided to systems engineering decision making in the FAA. As part of this task, a preliminary assessment was conducted of some of the key issues facing the FAA today and of some of the metrics that can be used in the near term to address them. Another study was conducted of the NASPAC and SIMMOD simulation models to aid in ensuring that the two models can be applied in a coordinated and complementary manner.

The analyses to be performed in FY93 include studies of interest to various FAA offices. The emphasis of the work to be conducted will focus on projects that represent high priority tasks related to systems engineering decision making, in which capacity and system performance are often the major concern.

NASPAC SMS will continue to be improved in FY93. The improvements will focus on the development of a version of the model that can be applied quickly and that does not require extensive training or skill to operate. The documentation for the SMS will also be updated and augmented to include components of the system that have not been documented in detail to date.

G.2.4 Vertical Flight Program

Responsible Division: ARD-30
Contact Person: Steve Fisher, 202/267-8535

Purpose

To improve the safety and efficiency of vertical flight (VF) operations and increase NAS capacity through R,E&D into air traffic rules and operational procedures; heliport/vertiport design and planning; and aircraft/aircrew certification training.

Program Milestones

The Rotorcraft Master Plan (RMP) envisions advanced VF technologies, like the tiltrotor, providing scheduled short-haul passenger and cargo service for up to 10 percent of projected domestic air travel. To accomplish this expanded use of vertical flight, the FAA is responsible for developing the appropriate infrastructure and regulations in parallel with industry's actions and commitment to develop and operate market-responsive aircraft.

The VF program is being executed through many concurrent projects and activities, which are divided into three technical sub-program areas: Air Infrastructure, Ground Infrastructure, and Aircraft/Aircrew.

The Air Infrastructure sub-program will provide R,E&D to enable reliable, all-weather operations for VF passenger and cargo aircraft. The research results will include developing both visual and instrument terminal approach and departure procedures, steeper IFR approach angles, improvements in low altitude navigation and air traffic control services, VF air route design, and noise abatement procedures.

Ground Infrastructure research will address heliport and vertiport design and planning issues, including the terminal area facilities and ground-based support systems that will be needed to implement safe, all-weather, 24-hour flight operations. Developing obstacle avoidance capabilities is a critical design-related effort. Research will include applying lessons learned from detailed accident and rotorcraft operations analyses. Simulation will be used extensively to collect data, analyze scenarios, and provide training to facilitate safe operations.

Aircraft/Aircrew research will develop minimum performance criteria for visual scenes and motion-base simulators; evaluate state-of-the-art flight performance for cockpit design technology; and develop crew and aircraft performance standards for determination of display and control integration requirements. Research will also be conducted in support of the FAA's responsibilities to certificate both conventional and advanced technology VF aircraft.

Products

- Terminal area approach procedure requirements
- ATC route standards, procedures and models
- Vertiport/heliport design standards
- Improved VF noise planning model
- VF noise abatement procedures
- Rotorcraft simulator standards
- VF aircrew training and certification requirements

Schedule

- Publish vertiport design requirements for 1996 Olympics FY94
- Produce audio visual training aids and workbooks to assist in training Expert Decision Making techniques FY94
- Publish civil tiltrotor air carrier profitability report FY94
- Identify night vision enhancement device technology applications FY95
- Publish advanced technology VF performanceand demonstration guidelines FY95
- Publish results of test and analysis of a variety of heliport and vertiport design parameters, including minimum required VFR airspace for curved approaches and departures, minimum parking and maneuvering areas, marking and lighting, and rotorwash protection requirements.................... FY96
- Conduct extensive VF noise data collection FY96
- Publish Technical Report supporting certification requirements of VF aircraft display formats FY96
- Publish national-level guidelines for joint industry/local government advanced technology VF demonstration program.............. FY96
- Develop low noise conversion corridor criteria for tiltrotors FY97
- Publish terminal area procedures for steep-angle approach and departure FY97
- Publish simulation-based analysis of pilot performance in an obstacle-rich environment, with results being used to evaluate necessary heliport and vertiport design criteria FY97
- Publish CTR noise certification requirements FY98

G.3 En Route Capacity Related Projects

G.3.1 Airspace System Models: Sector Design Analysis Tool (SDAT)

Responsible Division: AOR-200
Contact Person: Ken Geissinger, 202/267-7568

Purpose

To develop analytic models, including computer simulations, for evaluating current and future impacts of proposed new National Airspace System (NAS) equipment, air traffic control (ATC) procedural changes, and revised airspace configurations.

The models will provide quantitative measurements of system performance in terms of safety, capacity, efficiency, and controller workload. This program supports provisions of the Aviation Safety Research Act of 1988, which requires development of models of the ATC system to predict safety and capacity problems.

The models will share common elements, but will be tailored for specific ATC needs and users. For example, the first product will be a tool for use by en route airspace designers to evaluate the impact of alternative designs on controller workload. The next product will address terminal airspace. These models will allow analyses of proposed changes in procedures, traffic flow, and airspace design in terms of safety, efficiency, and controller workload. Later products will address the impacts of proposed new NAS equipment and automation on the ATC environment.

Program Milestones

An en route Sector Design Analysis Tool has been developed. This tool analyzes given traffic flow data and estimates separation assurance workload. Validation and demonstration of the concept was achieved in FY91. In FY92, it was given the capability to read airspace design data and aircraft track data available at the facilities and to accept user changes to these data interactively. This tool will be expanded to include other controller workload elements in FY93. The SDAT will be test implemented at two sites in FY93 and actual implementation will begin in FY94.

Products

- A computer-based Sector Design Analysis Tool capable of being used on ARTCC existing automation equipment by air traffic personnel to assist in resectorization
- Terminal airspace design evaluation tool
- National airspace design evaluation tool
- NAS equipment evaluation model
- Automated collision risk evaluation tool

G.3.2 Airspace and Traffic Optimization: Dynamic Ocean Tracking System (DOTS)

Responsible Division: ARD-20
Contact Person: Chuck Eng, 202/267-7243

Purpose

To minimize fuel consumption, facilitate aircraft operations for users and the ATC system, and improve ATC designs and procedures.

To develop a tool to optimize flight track design and track utilization.

Computer-efficient algorithms have been developed which determine an aircraft's projected time and fuel consumption over the ocean. Optimization techniques use these algorithms, together with an automatic dynamic weather database and varying ATC separation criteria, to design flexible fuel-efficient tracks for oceanic traffic. A similar process is used to advise individual scheduled flights of the optimal track based on their oceanic entry time and other aircraft traffic they will encounter.

Tests have shown that aircraft flying on a typical trans-Pacific route fly six or eight thousand feet lower than their most efficient altitude. This is due to large separation requirements and the fact that airlines are not able to determine airspace availability. Rough estimates indicate that a DOTS capability will save between 5 percent and 7 percent on fuel. Other benefits include reduced controller workload associated with controlling aircraft on structured rather than random track systems designed to flex with changing wind conditions.

With the addition of ADS functionality from ODAPS, the DOTS dynamic wind and temperature data base and track advisory capability will be greatly enhanced. Traffic planners will be able to take advantage of wind and temperature changes to identify fuel-efficient alternative tracks in near real time.

The track generation capability will be certified to ensure that generated tracks meet international separation standards required for safety. An airspace reservation system will be developed to enhance airspace utilization leading to substantially reduced airline operating cost. Integration of oceanic and domestic traffic planning capability will be implemented to allow seamless traffic management across domestic and oceanic boundaries for improved airspace use. The DOTS functionality will be integrated with the Advanced Traffic Management System (ATMS).

Program Milestones

In FY91, track generation programs and traffic management displays were installed in New York, Oakland, and Anchorage ARTCCs. The tests showed that there was a cost benefit to having aircraft fly the generated flight tracks. In addition, DOTS was installed in the Air Traffic System Command Center (Central Flow).

In FY92, a track advisory prototype system was installed in the Oakland ARTCC and testing of the prototype is continuing. Work will start soon on DOTS to ATMS integration, airspace reservation system and certifying the track generation function.

Products

- Algorithms for minimal fuel path generation for any set of position, altitude, velocity, wind, weather, and time constraints
- Prototype hardware and software
- Algorithms and operational guidelines for minimum fuel computations within the oceanic ATC system
- Dynamic simulation model
- Applications

G.3.3 Oceanic Display and Planning System (ODAPS)

Responsible Division: ANA-150
Contact Person: Richard Simon, 202/267-8341

Purpose

To provide an automation infrastructure for oceanic airspace that includes automatic receipt and processing of aircraft position reports, a dynamic flight plan database, an aircraft situation display, and a conflict probe. The system will allow controllers to more effectively utilize oceanic airspace without revising separation standards.

Oceanic controllers in facilities on the east and west coasts of the United States are confronted with an increasing need for random and direct routes and are not able to visualize these routes from data presented on current flight progress strips or plotting boards. The Oceanic Display and Planning System (ODAPS) will reduce this problem by providing controllers with adequate information to apply separation standards in a timely manner. Requirements validation and design have been completed. Systems have been delivered to both sites, Site Acceptance Tests have been conducted, and ODAPS is operational in Oakland and in the Initial Operational Capacity (IOC) status at New York.

Program Milestones

The contractor has resolved all high and critical priority software problems identified to date. Nineteen NAS Change Proposals (NCPs) have been approved. These NCPs are enhancements to the basic system and are deemed necessary to fully implement ODAPS. The schedule was re-baselined to reflect the impact of these NCPs. Following demonstration of 14 NCPs, five additional NCPs were identified for full implementation. These five are expected to be implemented by mid-1993.

The ODAPS contract options have been exercised for the New York ARTCC and the FAATC test bed. The FAATC System Support Facility is operational to support maintenance and enhancements.

Products

Oceanic display and flight data automation for two ARTCCs

- ZOA S/W handoff to ATR-400 .... 07/91
- Last integration test complete (IOC) (ZNY) 05/92
- Last ORD complete (ZNY) 04/93

G.3.4 Traffic Management System (TMS)

Responsible Division: ANA-300
Contact Person: Harry B. Kane, 202/267-8336

Purpose

To upgrade the present flow control system into an integrated Traffic Management System (TMS) which operates at the national level through the Air Traffic Control System Command Center (ATCSCC) and the local level through traffic management units (TMUs).

The upgrading of the traffic management system is designed to improve air traffic system efficiency, minimize delays, expand services, and be more responsive to user requirements. The TMS functions include Central Altitude Reservation Function (CARF); Airport Reservation Function (ARF); Emergency Operations Facility (EOF); Central Flow Weather Service Unit (CFWSU); various flow management programs with integrated metering functions such as the Departure Sequencing Program (DSP), En route Spacing Program (ESP), and the Arrival Sequencing Program (ASP); and Enhanced TMS (ETMS) functions including the Aircraft Situation Display (ASD) and Monitor Alert (MA).

Program Milestones

Phase I of the TMS program has been completed. It replaced outdated computer systems, implemented a data communications system to interface users and ARTCC computers in a two-way data mode interfacility flow control network (IFCN), and relocated CARF and the automation staff to FAA headquarters.

Phase II has provided the Enhanced Traffic Management System, which is a computer network that implements the aircraft situation display (ASD) and monitor alert (MA) functions developed by the Advanced Traffic Management System (ATMS) research and development program, for the Air Traffic Control System Command Center (ATCSCC), all Air Route Traffic Control Centers (ARTCCs), and several Terminal Radar Approach Control Centers (TRACONs). New computer systems with color graphics workstations have also been provided to the ATCSCC, TMUs, and the FAA Technical Center, which interface with the Traffic Management Computer Complex (TMCC), the host computers, and the ETMS computers to provide enhanced information displays and near real-time flight data. The Arrival Sequencing Program (ASP) and En Route Spacing Program (ESP) Package 1 metering enhancements to the host computers have also been provided.

Continuing Phase II activities are focused on replacing the TMCC, completing implementation of ASD and MA functions in all en route centers, and selected high activity TRACONs.

Follow-on activities to Phase II will include providing automation equipment to non-en route facilities, relocating the ETMS computers from the development location to an FAA facility, providing an enhanced high data rate interface between the Host and ETMS computers, integrating DSP into the TMS and providing meter list display capabilities for the ARTCCs. Other activities will include implementing ATMS functions on the ETMS, providing TMS hardware and software in the Advanced Automation System time frame until the next generation TMS becomes operational, and improving traffic management performance analysis capabilities by developing standards, procedures, and tools to facilitate the accurate reporting, collection, and analysis of NAS data.

Products

- One Air Traffic Control Command Center, comprised of a CFCF, CARF, ARF, CFWSU and a central altitude reservations function. The TMS computer complex is located at the FAATC. ETMS computers are currently located at the John A. Volpe National Transportation Systems Center, Cambridge, Massachusetts.
- One computer program suitable for adaptation and use at 20 domestic ARTCCs and selected TRACONs.

G.3.5 LORAN-C Systems

Responsible Division: AND-30
Contact Person: Donald Stadtler, 202/267-8709

Purpose

To conduct necessary procurement and implementation projects to meet FAA responsibilities for the use of LORAN-C in the NAS.

LORAN-C is the government's navigation aid for coastal areas of the United States, including southwestern Alaska. Signal coverage was increased in 1991 over the mid-continent area and now all 48 contiguous states have LORAN-C service. Low-cost avionics have made LORAN-C an attractive area navigation aid for general aviation; it has been approved for en route and non-precision approach use under instrument conditions. One goal remains: to bring LORAN-C into maximum use in the NAS as a supplemental aid by completion of the installation of signal monitors to support non-precision approaches throughout the NAS. The signal monitors will provide the seasonal time difference correction information required to accurately perform a non-precision approach.

Program Milestones

Two new LORAN-C chains of stations were completed in the U.S. mid-continent in April 1991. LORAN-C monitor units consist of two parts: monitors and interface electronics to VOR equipment. Signal monitors were installed at 196 sites. Installation will be completed in 1992 when interface electronics are placed in the host facilities.

Products

- LORAN-C Signal Monitor System
- LORAN-C mid-continent transmitters

G.3.6 Automatic Dependent Surveillance

Responsible Division: ARD-100
Contact Person: Peter Massoglia, 202/267-9845

Purpose

To support the development and implementation of an automatic dependent surveillance (ADS) function to improve safety and provide economic benefits to users of oceanic airspace, as well as to aid oceanic controllers in effectively controlling oceanic airspace, with evolutionary applications to domestic airspace.

The ADS function will provide for improvement in tactical and strategic control of aircraft. Automated processing and analysis of frequent position reports will result in nearly real-time monitoring of aircraft movement. The capability of ADS to provide timely and high-integrity aircraft position data via a satellite air/ground data link will permit possible reduction in separation standards, as well as increased accommodation of user-preferred routes and trajectories.

The program will be developed in incremental steps, with the first step being the ADS capability. The second step will add two-way digital data communications for air traffic command and control. Follow-on steps will add additional features, including digital voice, all leading to safer and more efficient use of the airspace.

Program Milestones

Implementation of ADS will be at the Oakland and New York Centers only. Step 1 is scheduled for 1994 and Step 2 for 1995.

Products

- ADS (Step 1) mod operational on Oceanic Development Facility (ODF)
- Perform Engineering/HF Trials
- Complete Data Link (Step 2) Requirements Definition
- ADS Step 1 installed at Oakland and New York
- Complete Step 2 Operational Concepts and System Specification
- ADS Data Link (Step 2) mod operational on ODF
- Complete display enhancements to Oceanic ATC
- Complete integration and validation of Step 2 mod on ODF
- Complete avionics development support standards
- ADS Data Link (Step 2) installed at Oakland and New York
- Develop international ADS standards and operational procedures (SOPS)
- Develop minimum operational performance standards (MOPS)

G.3.7 Separation Standards

Responsible Division: ARD-100
Contact Person: Gene Wong, 202/646-3475

Purpose

To provide quantitative guidance for domestic and international decision-making concerning adequate minimum safe horizontal and vertical separation standards.

Quantitative guidance based on statistical analysis is provided to support decision-making to reduce vertical and horizontal (lateral and longitudinal) separation requirements. This activity consists of model development, data collection, data reduction, and analysis. It also includes: (1) the investigation of the effect on separation standards of imposing tighter required navigational performance specifications, (2) determination of the effect of tolerating mixtures in the total aircraft population of both old and new specifications, and (3) investigations of the potential for the safe improvement of separation requirements in a system with advanced future navigation systems. These analyses include considerations of the role of pilot and controller and their feedback loop process in evaluating navigational performance within the framework of collision risk methodology. This program also provides support in developing and establishing methods and procedures for monitoring standards compliance and safety.

This effort will also help establish separation requirements based on Automatic Dependent Surveillance (ADS), Area Navigation (RNAV), and other developing technologies for supporting reduced permissible separation minima.

The oceanic horizontal separation standards program will analyze separation standards in the North Atlantic, West Atlantic, Central East Pacific, and North Pacific route systems. It will examine the impact of various system improvements on safe minimal horizontal and longitudinal spacings for oceanic traffic. As oceanic control becomes increasingly flexible through automation, this program will establish appropriate separation standards to facilitate maximum traffic efficiency and safety.

Onboard, time-based navigation capabilities and associated ATC capabilities will be analyzed in an effort to study the feasibility of time-based separation standards.

The vertical separation program will determine the practical feasibility of reducing the vertical separation minimum between FL290 and FL410 from 2,000 to 1,000 feet, thus adding six additional flight levels in this altitude range. This change would provide the ATC system with enhanced flexibility to accommodate user-preferred flight profiles and would lead to substantial savings in user fuel costs.

Program Milestones

In FY90, the ICAO guidance material for world-wide and regional reduction of the high-altitude vertical separation standard from 2,000 to 1,000 feet was finalized.

In FY91 the ICAO guidance material amending current Pacific track longitudinal separation standards was completed, including distance, as well as time. This amendment resulted in reduced separation minimums.

In FY93, the activities associated with implementing the 1,000 foot vertical separation standard in North Atlantic airspace by 1996 will be continued. The investigation of aircraft height-keeping performance will be conducted by collecting and evaluating data from studies and engineering trials.

In FY93-94, ICAO guidance material for separation standards in the horizontal plane will continue to be developed. The four major items are area navigation (RNAV), Required Navigation Performance (RNP), Automatic Dependent Surveillance (ADS), and General Guidance on Separation Standards for Airspace Planners. The goal is to complete RNAV guidance in 1994-1995. The RNP was requested by the ICAO Future Air Navigation Systems (FANS) committee and has implications for the world-wide use of global positioning system (GPS) and establishing separation standards. The goal is to complete RNP guidance in the FY94 period. The introduction of ADS will provide near real time surveillance and communications in many areas that presently depend on pilot reports over high frequency communications. A new or modified Collision Risk Model (CRM) is being developed to establish quantitative guidance in establishing separation standards based on new technologies. These new technologies include ADS , intervention and satellite based navigation and communication. This effort is expected to be completed in 1995-1996. The final major effort is the continued work on developing general guidance on separation standards for airspace planners. This effort is expected to be completed in FY95.

Products

Horizontal Separation Standards

- Reports on the feasibility of reduced horizontal separation in oceanic airspace
- Reports on simulation and test results for reduced horizontal oceanic separations
- Data packages for international coordination of horizontal oceanic separation standards

Vertical Separation Standards

- Data analysis and operational tests and evaluation of reduced vertical separation
- Recommendations for rulemaking on vertical separation standards
- Input to ICAO documents
- NASP Group to implement 1,000 ft. vertical separation standards in 1996. This will be the first time it will be used in flight levels above 290.

G.3.8 Advanced Traffic Management System (ATMS)

Responsible Division: ARD-100
Contact Person: Stephen M. Alvania, 202/267-3078

Purpose

To reduce delays and enhance operating efficiencies through a highly automated traffic management system.

The ATMS program is the FAA research and development effort in direct support of the operational Enhanced Traffic Management System (ETMS). The ATMS is used to investigate automation and technology applications that will enhance the operational capabilities of the FAA Traffic Management System. The ATMS program is structured as the development of a sequence of evolutionary flow management capabilities which, once determined to be operationally beneficial, migrate to the operational ETMS system through a common development/testbed facility. The ATMS evolutionary stages currently defined are: Aircraft Situation Display (ASD) to monitor the NAS in “near real time;” Monitor Alert (MA) to automatically alert flow managers to projected congestion and delay conditions; Automated Demand Resolution (ADR) to generate alternative flow management strategies that deal with the projected conditions; Strategy Evaluation (SE) to provide real-time analytical support to the flow management decision-making process; and Automated Execution (AEX) to automatically distribute facility-specific flow management directives that will implement the selected strategy.

Program Milestones

The Aircraft Situation Display (ASD) and Monitor Alert (MA) functions are currently being deployed as part of the operational ETMS at the Air Traffic Control System Command Center (ATCSCC), all ARTCCs, and selected TRACONs.

Prototype Automated Demand Resolution (ADR) algorithms are being designed and incorporated into the ATMS testbed for evaluation. During FY91 and FY92, these algorithms will be tested and refined. Migration to the ETMS is expected in FY93.

The development of the Strategy Evaluation (SE) function will begin in FY93 with migration to the ETMS anticipated in FY94.

The Automated Execution (AEX) function will be significantly more sophisticated than the previous stages. Development of this function is expected to commence in FY94, with migration to the ETMS currently scheduled for FY98.

Products

- Prototype Aircraft Situation Display (ASD) functionality
- Prototype Monitor Alert (MA) functionality
- Prototype Automated Demand Resolution (ADR) functionality
- Prototype Strategy Evaluation (SE) functionality
- Prototype Automated Execution (AEX) functionality

G.3.9 Automated En Route Air Traffic Control (AERA)

Responsible Division: ACD-300
Contact Person: Stan Pszczolkowski, 609/484-6844

Purpose

To provide an interactive software capability for the Area Control Facility (ACF) to plan and monitor the four-dimensional flow of air traffic.

Specifically, AERA will provide the capability to: (1) permit most aircraft on IFR flight plans to fly fuel-efficient profiles, (2) increase the safety of the system by reducing the potential for operational errors, (3) increase system capacity by integrating en route metering with local and national flow control, and (4) increase controller productivity by increasing the number of aircraft and volume of airspace that a control team can safely manage.

AERA's implementation approach was changed as part of the revised strategy for incremental development of the Area Control Computer Complex (ACCC). These changes include the definition of Full AERA Services (FAS) as the combined functionality of AERA 1 and AERA 2 and the introduction of an interim operational step between the basic ACCC and FAS. This interim step, called Introductory AERA Services (IAS), was established to facilitate operational and technical transition as well as provide timely system benefits. IAS includes the original AERA 1 capabilities, some of which were modified to ensure upward compatibility to FAS, and several AERA 2 controller automation aids. IAS will be operational approximately twelve (12) months after ACCC implementation. IAS uses the ACCC's four-dimensional flight path trajectory estimation model to support the following features:

- Flight plan conflict probe ,which will predict potential violations of separation standards between aircraft and between aircraft and special use (e.g., restricted) airspace
- Sector workload analysis, which will calculate and display personnel workload measures to supervisors and specialists to assist them in balancing sector staffing levels
- Trial flight plan function, which will allow controllers to evaluate alternative clearances prior to issuing them to aircraft
- Automated reconformance ,which will adjust the calculated trajectory to reflect the aircraft's actual flight path and notify the controller of each adjustment in order to maintain system safety
- Automated replan ,which will aid the controller in granting conflict-free user requests at the earliest possible time

Approximately one year after the implementation of IAS, the remaining FAS capabilities (originally part of AERA 2) will be implemented. These extend IAS from detecting potential conflicts to providing the controller with suggested resolutions. The automation generated resolutions will avoid the predicted conflict, not cause additional conflicts and minimize the deviation from the aircraft's preferred route.

Each AERA development package will undergo a series of rigorous engineering and validation steps consisting of algorithmic development, operational suitability evaluations, computer performance functional specification generation, software design and development, and comprehensive operational test and evaluation.

Program Milestones

Functional specifications for the AERA 1 functions were completed in FY84. AERA 1 research and development was completed in early FY85. Modifications to the original AERA 1 functionality were made in FY92 to transform AERA 1 into Introductory AERA Services (IAS). IAS development, operational evaluation, and implementation will be accomplished as part of the AAS contract.

AERA 2 functional specifications were completed in FY86. Prototype laboratory evaluations were completed in FY90, and detailed algorithmic and computer/human interaction specifications were produced.

AERA 2 design and analysis began in FY90 as part of the AAS contract. In FY92, activities were adjusted to accommodate the revised approach to Full AERA Services implementation. AERA 2's automated problem resolution capability and supporting functions will continue to be designed and developed as part of the AAS contract in coordination with IAS development. This software will undergo operational evaluations in ATC laboratory simulations. After operational suitability has been demonstrated, the software will be finalized and implemented.

From December 1991 through November 1992: (1) AAS specifications were revised to reflect the new approach to Full AERA Services implementation; (2) AERA design activities under the revised implementation approach continued and algorithmic and computer-human interface risk reduction demonstrations were conducted; (3) analysis of the extendibility of the detailed ACCC design to IAS was completed, as well as preliminary extendibility analysis to FAS.

Products

- AERA will provide key en route traffic conditions and prediction data to the Traffic Managment System (TMS). The upgraded traffic management system will be integrated with AERA to keep both short- and long term traffic planning coordinated
- The AAS ACCC step has been replanned to include IAS and FAS incremental development
- Weather products provided by CWP will be used by AERA. More accurate wind data will improve AERA performance
- Aeronautical Data-Link, interfaced through AAS, will provide automated controller/pilot data and advisory interchange

G.3.10 Operational Traffic Flow Planning

Responsible Division: AOR-200
Contact Person: Mark Salanski, 202/267-7809

Purpose

To provide dynamic, fast-time automated traffic planning and decision support tools which (1) plan daily air traffic flow based on user schedules, aircraft performance, weather, capacity and other operational situations; (2) develop traffic plans for joint FAA/user planning and decision-making; (3) predict traffic problems and probable delay locations; and (4) generate routes and corresponding traffic flow strategies that minimize time and fuel for scheduled traffic.

A coordinated system of interactive computer models and decision support tools are being developed through rapid prototyping. The development program capitalizes upon proven technology such as the Dynamic Ocean Tracking System (DOTS) and will extend this technology to the domestic U.S. airspace. Other prototyping efforts will be based on previously developed optimization and simulation technology.

Program Milestones

In FY91, the High Altitude Route System (HARS) program completed development and evaluation of a test-bed prototype. In FY92, the prototype was used as the "core" of the initial operational HARS planning model for field implementation at the ATCSCC and TMUs. The HARS initial prototype optimizes track generation and traffic flow planning for major U.S. city pairs. HARS also includes an alternate flow generation function (FLOWALTS) that provides rapid analysis of alternate route and flow strategies. HARS displays live air traffic and weather over a background of sector boundaries, jet routes, fixes, and airports. HARS field prototype development and demonstration will begin in FY93, and will provide both follow-on enhancements enabling full track generation and traffic optimization for high altitude traffic anywhere in the U.S. and integration with oceanic traffic management systems.

In FY92, a fast-time simulation model for traffic flow planning (FLOWSIM) was developed to help the FAA plan daily air traffic flow based on user schedules, aircraft performance, weather, capacity and other operational situations; predict traffic problems and probable delay locations; and facilitate joint FAA/user planning and decision-making. Development of a consolidated U.S. airspace data model began in FY92 and will demonstrate and test an initial prototype in FY93. Finally, the development of a National Airspace System model, which will provide the capability for detailed prediction and simulation of daily traffic and flow strategies, will also begin in FY93. It will utilize and integrate the technologies and tools developed in the preceding projects (e.g., HARS, FLOWSIM, FLOWALTS, etc.).

Products

- Algorithms and models for optimized, fuel-efficient high altitude routes
- Algorithms and models for developing optimum departure and arrival sequencing plans
- Fast-time simulation of traffic flow plans
- Algorithms to generate alternate traffic flow strategies by computer ranking fuel and time impacts
- An integrated U.S. airspace data model for detailed national simulation
- Detailed prediction and simulation of daily traffic

G.3.11 ATC Automation Bridge Development: TRACON Re-code and Display Channel Complex

Responsible Division: ARD-100
Contact Person: Royce Wilkerson, 202/267-7547

Purpose

To develop design alternatives and conduct risk mitigation demonstration for the development of a TRACON replacement system and en-route display channel replacement system.

Advanced Automation System (AAS) end-state equipment will be used in this system where technically feasible. The minimum functional capability of this new system will be equivalent to the current system. Capacity and display capabilities will be increased to allow for future growth.

Program Milestones

Alternative design approaches will be identified in FY92. Detailed designs will be completed in FY93. Risk mitigation demonstrations will be conducted in FY93.

Products

- Design alternatives for TRACON systems and en route display channel systems

G.3.12 Ground Delay Substitution Analysis

Responsible Division: AOR-100
Contact Person: Robert Rovinsky, 202/267-9952

Purpose

To provide FAA's Air Traffic Management Service with a set of strategies to follow to improve the ground delay substitution process.

Program Milestones and Products

A report on the ground delay substitution system to help air traffic management establish policies and operational options was prepared in October 1992. Work is continuing to develop ground delay policies, management tools, and operational options in support of air traffic systems management.

G.3.13 Meteorologist Weather Processor (MWP)

Responsible Division: ANW-300
Contact Person: Jeanne Rush, 202/267-7800

Purpose

To implement a system that provides for the processing of alphanumeric and graphic weather products received from the National Weather Service (NWS) and radar and satellite imagery.

The MWP supports improved services by the Center Weather Service Units (CWSUs) at Air Route Traffic Control Centers (ARTCCs) and the Central Flow Weather Service Unit (CFWSU) at the Air Traffic Control System Command Center (ATCSCC).

Program Milestones

The MWP system has been delivered to all operational sites as of November 1991.

Products

- MWP systems, including an interactive workstation for the CWSU/CFWSU and briefing terminals for air traffic supervisors and traffic management coordinators to display alphanumeric, graphic, radar, and satellite weather products.

G.3.14 Aviation Weather System

Responsible Division: ARD-220
Contact Person: Arthur Hansen, 202/267-9743

Purpose

To improve the analysis and forecasting of weather that affects the safety, capacity, and efficiency of the NAS.

To develop sensors for the collection and analysis of meteorological data from both airborne and ground operations.

To develop training programs to improve aviation weather services.

To develop and demonstrate, in an operational environment, airborne detection and warning technology leading to reduced risks associated with severe windshear conditions.

To provide weather services that will reduce the weather information handling workload of air traffic controllers.

Program Milestones

High resolution upper wind and temperature analyses and forecasts will be provided operationally every 3 hours beginning in 1992.

In FY91, the development of the flight crew and ground-system flight procedures were developed to support the flight test activities in FY92. The first flight tests of combined radar, lidar, infrared, and windshear data communications will take place in the summer of FY92 and be completed in FY93.

Products

- Sensors to measure humidity, visibility, and temperature icing aboard air carriers
- Mesoscale numerical prediction models, data assimilation, nowcasting methods, and model evaluation for analysis and forecasting of aviation weather parameters
- Experimental forecast center for testing and evaluating new products and methods
- Enhanced terminal weather products (e.g., hazardous storm cell detection)
- New local area nowcasts and short-range forecasting techniques using statistical techniques and expert systems
- Algorithms to quantify the hazard from windshear data communications
- Modules for computer-aided training in aviation weather
- Advanced airborne windshear sensors for integration into the flight deck

G.3.15 Aeronautical Data Link

Responsible Division: ARD-60
Contact Person: Ron Jones, 202/267-8655

Purpose

To develop aeronautical data link communications standards associated with the Aeronautical Telecommunications Network (ATN).

To develop and implement ATC and non-ATC data link applications.

Program Milestones

Phase One of the Tower Data Link System (TDLS) providing pre-departure clearance (PDC) service was displayed at 29 airports in FY91 and at a 30th airport in FY92. A Data Link Processor (DLP) was delivered to the first operational site in FY91. The first operational use of DLP will be a DLP weather database available via Mode S, scheduled for early FY93. A prototype digital ATIS service using a tower data link system was evaluated in FY92 with deployment of the operational ATIS service in FY93. Development of DLP Build-2 enhancements to support added communications functionality for the Aeronautical Telecommunication Network (ATN) and additional data link services began in FY91 with operational deployment planned for FY96. Initial en route and terminal ATC services are being developed with implementation planned in the FY96-98 time frame.

Products

- Communications standards (RTCA, ICAO, AEEC, etc.)
- Data Link Processor that supports a weather database for pilot access (Build-1 and support for the Aeronautical Telecommunications Network Build-2)
- Tower datalink system to support Pre-Departure Clearance delivery and other tower applications
- Specifications for ATC and non-ATC data link applications (e.g., Automated Terminal Information System, wind shear alerts, hazardous weather information, traffic information, and en route and terminal automation)

G.3.16 Satellite Navigation

Responsible Division: ARD-70
Contact Person: Joe Dorfler, 202/267-8463

Purpose

To develop augmentation(s) and verify the use of satellite navigation systems, such as the Global Positioning System (GPS), for civil aviation in order to obtain the capacity and flexibility benefits of a space-based navigation system that will be available for use in the NAS for en route, terminal, departure, non-precision, and precision approaches and for airport surface guidance everywhere.

Program Milestones

In FY91, Minimum Operational Performance Standards (MOPS) for GPS avionics were developed to support the use of GPS as a navigation supplement. This enabled a Technical Standards Order (TSO) to be developed during FY92 and FY93 for certification of avionics, and it enabled the Flight Standards and Aircraft Certification Services to authorized operational use of GPS in June 1993. During the remainder of FY93, requirements for augmentation to GPS to support its use as a sole-means navigation source will be developed and validated. MOPS for use of GPS and GPS hybrids were initiated in FY93 and will be completed over the next year. The MOPS will apply to GPS augmented with Global Navigation Satellite System (GLONASS), inertial systems, LORAN-C, and/or Wide-Area Integrity Broadcast with Wide-Area Differential GPS (WIB/WDGPS). An accompanying TSO will be written in FY94. A Request for Proposals (RFP) for the ground stations and communications links for WIB/WDGPS will be released in FY94. A study and verification of the feasibility of the use of GPS for Category II and III precision approaches will then proceed and is planned for completion by the end of FY95.

Products

- Performance standards for aircraft avionics
- GPS system performance specifications
- Requirements for augmenting GPS for use as sole-means navigation, non-precision, and special Category I precision approaches

G.4 Airport Capacity Related Projects

G.4.1 Airport Capacity Design Team Studies

Responsible Division: ASC-100
Contact Person: James McMahon, 202/267-7425

Purpose

To establish a forum, sponsored and supported by the FAA, in which airport management, the local FAA, airlines, commuters, industry groups, and airport planning consultants work together to develop technically feasible alternatives for improving airport capacity and reducing delay.

Design team studies have been established at airports where the need for capacity improvement is identified. The studies typically investigate application of new air traffic control procedures, navigation aids, system installations, airport development, and other prospective capacity improvements. Alternatives are then evaluated using state-of-the-art simulations. The simulations provide a measure of benefit in terms of hours of delay reduction and allow the FAA to refine modeling techniques while gaining operational benefits through assistance to the design team studies.

Program Milestones

During FY92, design team efforts were successfully completed in Pittsburgh, Philadelphia, San Juan, San Antonio, New Orleans, and Honolulu. Design team studies are still underway at Ft. Lauderdale, Houston, Albuquerque, Indianapolis, Minneapolis-St. Paul, Port Columbus, and Cleveland. Among the airports being considered for design team studies in 1993 are Detroit, El Paso, Tulsa, and Las Vegas. New runways are being planned at Atlanta, Detroit, Kansas City, Orlando, Phoenix, St. Louis, and Washington-Dulles as a direct result of airport capacity design team efforts.

Over 500 proposals for enhancing capacity have been developed for analysis by the design teams since the program began in 1985. Completed design team studies resulted in over 120 recommendations in FY91-92. Of these, 76 were completed and another 37 were either under construction or in the environmental assessment process by the end of FY92.

Products

- Action plans incorporating the projects and programs that produce capacity improvements and delay reductions at airports under study
- Analysis of airport capacity

G.4.2 Aviation System Capacity Planning

Responsible Division: ASC-100
Contact Person: James McMahon, 202/267-7425

Purpose

To develop a capacity plan that meets forecast increases in aircraft operations and allows aircraft to move safely through the airport and airspace environment.

Aviation System Capacity Planning is made up of airport design, airspace design, and approach procedures. Airport Capacity Design Teams, currently on-site at 11 airports, are made up of airport operators, the FAA, airlines, and other users. The team starts with a simulation of the current airport and adjacent airspace environment using actual operating data to establish a baseline. The team then develops a list of potential improvements to increase capacity and, using a variety of simulation and queuing models, tests their effect in the specific airport environment. Among the improvements investigated are airfield improvements, such as new runways and runway extensions; improved approach procedures, such as reduced longitudinal separations; new facilities and equipment, such as the Microwave Landing System (MLS); and user improvements, such as relocating a portion of the general aviation traffic to a nearby reliever airport. Those improvements found to produce the greatest capacity increases, together with the estimated delay reduction and cost-saving benefits of each, are integrated in the final report. Residual delay, after all enhancements are implemented, creates requirements for additional research and development into new capacity-enhancing approaches.

To provide for the projected increases in traffic and the implementation of the airport capacity design team recommendations, the airspace structure is redesigned and the traffic flows are modified to accommodate more aircraft and ease the burden on control facilities. Airspace redesign begins with the simulation of the airway environment of the air traffic control center. Actual operational data is used to establish a baseline. The airspace design team then develops alternatives such as more direct routing, segregating jet, turboprop, and prop traffic, and relocating cornerpost navigational aids to allow for more arrival and departure routes. These alternatives are simulated to determine their effect on delay, travel time, sector loading, and aircraft operating cost. The most successful alternatives are incorporated into a plan to redesign the airspace for increased capacity and efficiency. Ultimately, all 20 centers, encompassing the whole U.S. airspace system, will be included in the baseline run, making it possible to accurately evaluate the effect of a specific airspace redesign project on the entire system.

Terminal approach procedures are designed to increase the number of arrivals in poor weather. In most cases these are multiple approach procedures aimed at allowing the simultaneous, or near-simultaneous use of more than one arrival runway. Implementation of many of these procedures is dependent on the use of new technology such as the Precision Runway Monitor (PRM) and the Converging Runway Display Aid (CRDA).

Program Milestones

In CY92, the 1993 Aviation System Capacity Plan will be produced, analyzing the benefits of new airport development, airspace changes, progress on implementing improved airspace procedures, and new technology to support airport, airspace, and procedures improvements. In addition, final reports of the airport capacity design teams at Pittsburgh, Philadelphia, San Juan, San Antonio, New Orleans and Honolulu will be issued. Airspace design teams are scheduled to complete reports for New York (Phase II), Oakland, and Miami/San Juan.

Products

- Aviation System Capacity Plans
- Airport Capacity Design Team Reports
- Airspace Analysis Technical Reports
- Approach Procedure Improvement Reports

G.4.3 Low-Level Wind Shear Alert System (LLWAS)

Responsible Division: ANW-400
Contact Person: Steve Hodges, 202/267-7849

Purpose

To monitor winds in the terminal area and alert the pilot, through the air traffic controller, when hazardous windshear conditions are detected, since windshear conditions occurring at low altitude in the terminal area are hazardous to aircraft encountering them during takeoff or final approach.

Program Milestones

The LLWAS program was initiated in early 1975. Among the sensors evaluated were pressure jump detectors, pulsed and CW Lasers, acoustic Doppler systems, pulsed Doppler radar and arrays of anemometers. The last technique was selected as the most cost-effective approach. Doppler radar promised the best capability at the time, but the technology was not sufficiently mature and the cost and technical risks were high. Full-scale development began in 1976, resulting in the evaluation of LLWAS at six airports. Production was initiated in 1978 and, of the 110 airports that were designated to receive the system, to date, 110 LLWAS units are now operating.

The program to upgrade the systems began in 1985 and contracts were awarded in 1987. The upgrade provided new processors and significantly improved the algorithm which increased the probability of detection and reduced the false alarm rate. This program was completed in the spring of 1991.

The LLWAS Expanded Network upgrade will provide additional sensors for microburst detection and identification. It will provide new displays for controllers and provide runway oriented wind shear information. The new upgrade has been tested at Denver and New Orleans and has been highly praised by pilots and controllers. The system saved a passenger aircraft in 1989. The competitive RFP to completely retrofit all 110 systems will be issued in 1993. The new system will have tall poles, new hardware and software, ice-free sensors, will interface with Terminal Weather Doppler Radar (TWDR), and will be equipped with a high reliability integrated sensor package.

Products

- One hundred and ten production systems, including spares, training, and documentation.

G.4.4 VORTAC Program

Responsible Division: ANN-300
Contact Person: Charles B. Ochoa, 202/267-6661

Purpose

To form a modern cost-effective national navigation network which provides required coverage through the replacement, relocation, conversion, and establishment of VORTAC, VOR/DME, and VHF Omnidirectional Range Test (VOT).

Very High Frequency Omnidirectional Ranges (VOR) with Distance Measuring Equipment (DME) or Tactical Air Navigation (TACAN) are en route air navigational and approach aids used by pilots to conduct safe and efficient flights and landings.

From FY82 through FY89, the FAA replaced 950 vacuum tube-type VOR and VORTAC systems with modern solid-state equipment. New Remote Maintenance Monitoring compatible DME systems will replace existing DME systems at 40 VOR/DME sites. The units removed from these sites will be redeployed to ILS sites. 76 tube-type VOTs will be replaced with solid-state equipment, and 35 new VOT systems will be established. VOR/DME facilities are being relocated to accommodate route structure changes, real estate considerations, and site suitability. Conventional VORs are being converted to Doppler VORs to solve siting problems and to obtain required signal coverage. Operational requirements that arise in various geographic areas require the establishment of VHF navigational aid services. Provisions have been made to establish 70 VOR/DME sites including new VOR/DME equipment at non-Federal takeover locations. DME systems will be added at 47 sites equipped with VOR only.

Program Milestones

All vacuum tube-type VOR and VORTAC equipment has been replaced with solid-state equipment which has embedded remote monitoring and control capabilities. DME service will be provided at all VOR facilities. A network plan has been developed to redistribute VORs to meet operational requirements. Tube-type VOT equipment will be replaced with solid-state equipment. VOR/DME and VOT sites will be established to meet operational requirements.

In FY90, the VOR/DME contract was awarded, the VOR/DME system design review was completed, and the design qualification test for VOT was completed.

Products

- To date, 725 VORTACs, 145 VOR/DMEs, and 90 VORs have been converted to Double Sideband (DSB) DVORs , 50 DVORs have been retrofitted with RMM, 35 VOTs have been established, and 76 VOTs have been replaced.
- In the next ten years, the FAA plans to establish 70 VOR/DMEs, establish 40 DMEs at VORs, replace 47 DMEs at VORs, reinstall 47 DMEs at ILSs, and convert 94 VORs to DSB DVOR.

G.4.5 Microwave Landing System (MLS)

Responsible Division: AND-30
Contact Person: Don Stadtler, 202/267-5857

Purpose

To develop and implement a new common civil/military precision approach and landing system that will meet the full range of user operational requirements well into the future.

MLS is currently the international standard replacement for the Instrument Landing System (ILS), and there are vendors in several countries that manufacture at least the Category I version of the MLS. There are also several manufacturers of the basic avionics sets. Some users are questioning the benefits of equipping with MLS, given possible alternatives of improvements in the ILS and the potential use of satellite-based systems for precision approaches. Other users are willing to equip with MLS to take advantage of its inherent advantages over ILS.

Program Milestones

A program to compare the frequency congestion potential of MLS and ILS has issued its report showing the limited number of ILS frequency allocations available in several major metropolitan areas. Advanced approach procedures in wide body aircraft have received favorable ratings from the airline crews flying very short final curved segments in a 747 simulator. Simulation of advanced procedures in a multi-airport environment determined the benefits of mls approaches to airports in the New York, Chicago, and San Francisco areas. To evaluate the general aviation/commuter capacity enhancements, mlss have been installed at JFK and Chicago Midway. Work has been underway on technical comparisons of ILS/MLS. Activities focusing on minima reductions are underway, including assessments of decision height and other MLS Terminal Instrument Procedures (TERPS) standards. A contract has been awarded to design a low-cost Precision Distance Measuring Equipment (DME/P) interrogator which will be used as part of the evaluation program, and then be made available to other manufacturers. MLS avionics costs have been analyzed for all categories of aircraft. Activity is underway to work with a major aircraft manufacturer to certify an entire class of aircraft for MLS Category III operations.The FAA's transition plan will provide an MLS at every commissioned ILS location.

Products

- A DME/P interrogator design
- Demonstrations of the MLSs operational and economic benefits
- Modifications to TERPS and approach procedures to effectively integrate MLS into the ATC system

G.4.6 Runway Visual Range (RVR) Systems

Responsible Division: ANN-200
Contact Person: John Saledas, 202/267-6529

Purpose

To establish and modernize existing Runway Visual Range (RVR) systems on qualifying Category I, II, III a/b ILS and MLS runways. RVRs support precision approach landing operations.

RVR equipment provides real-time measurement of visual range along the runway. The RVRs in the NAS utilize old technology and cannot be economically upgraded to satisfy the requirements of the NAS in the 1990s and beyond. A new generation RVR has been conceived to economically satisfy all future NAS operating and maintenance requirements.

Program Milestones

A contract has been awarded to procure 528 RVR systems. The RVR systems have completed all factory required testing. Production systems are scheduled for delivery in FY92-93.

Products

- 528 RVR systems with proper documentation

G.4.7 Airport Planning and Design

Responsible Division: ACD-100
Contact Person: Hector Daiutolo, 609/484-5283

Purpose

To improve airport designs to reduce runway occupancy and taxiing time and enhance aircraft ground operations.

Program Milestones

Studies will be conducted to improve airport design and configuration to decrease runway occupancy time and taxiing time from runways to gates and back to runways. An increase in airport capacity is expected to result from these studies. In addition, current and improved airport designs and configurations will be evaluated for compatibility with new aircraft.

In FY91, analyses of multiple exit/taxiway/crossover designs was initiated to determine the increase of aircraft flow rates afforded by the multiple systems over the current single lane system. The multiple systems are expected to handle more aircraft per unit time from runways to gates to runways, relieve gate congestion, and increase airport capacity. The study was completed in FY92.

Products

- Technical reports
- Computer programs and users guides
- Design criteria and guidelines for airports
- Test methods and procedures
- Analysis methods

G.4.8 Visual NAVAID

Responsible Division: ANN-300/ANN-200
Contact Person: Charles Ochoa, 202/267-6601 and Gary Skillicorn 202/267-6675

Purpose

To provide enhanced safety-related visual NAVAID at airports.

The facilities to be provided are medium intensity approach lighting system with runway alignment indicator lights (MALSR), runway-end identification lights (REIL), precision approach path indicator (PAPI), and omnidirectional airport lighting system (ODALS).

This program also includes the retrofitting of remote radio controls for visual aids to meet the operational requirements of air traffic controllers. The new system will permit single-button control of each visual aid function.

The establishment of visual NAVAID projects are based on each region submitting qualified candidates. In addition, the President's Task Force on aircrew complement recommended the installation of vertical guidance capability at all air carrier runways, and those locations not equipped with vertical guidance devices will receive priority consideration.

Products

- Current Capital Investment Plan (CIP) planning envisions the installation of 200 additional MALSRs, 300 REILs, 400 PAPIs, and 200 ODALs in the FY93 and beyond time frame

G.4.9 Precision Runway Monitor (PRM) for Closely Spaced Runways

Responsible Division: ANR-300
Contact Person: Byron Johnson, 202/267-8258

Purpose

To assess and demonstrate the feasibility of applying Precision Runway Monitor (PRM) to increase the aircraft arrival rate at airports with closely-spaced runways and develop the necessary equipment.

To develop the necessary equipment to apply PRM at airports with closely-spaced runways.

An airport's capacity to handle arriving aircraft is limited by the number of runways that are usable at any one time. In instrument meteorological conditions (IMC), the number of usable runways depends on the spacing between the runways. Without PRM — an enhanced radar and an associated controller display — simultaneous (independent) approaches are only allowed if runways are spaced at least 4,300 ft apart. With PRM, the spacing required between closely spaced runways is reduced to 3,400 ft. This change will allow more airports to conduct simultaneous independent approaches during inclement weather.

This project demonstrates the increases in an airport's arrival capacity that are possible with enhanced radar and controller displays. It will also produce a series of measurements on the effect of navigational accuracy, effect of the distance between the parallel runways, and response times of controllers, pilots, and aircraft. These measurements will also be useful for other similar applications such as runway spacings below 3,400 ft. and triple and quadruple parallel runways.

Program Milestones

Two engineering models of secondary beacon radars were tested: an electronically scanned (E-scan) beacon radar capable of a 0.5 second update interval (compared with a 4.8 second update interval available from today's radars), and a system that uses Mode S monopulse processing on back-to-back beacon antennas mounted on a conventionally rotating ASR system, capable of a 2.4 second update interval. The demonstrations of both E-scan and Mode S, begun January 1990, used improved high resolution displays that were acquired in 1989.

In FY90-91, engineering models were successfully demonstrated in conducting independent IFR approaches to parallel runways spaced 3,400 ft. apart. As a result, simultaneous IFR approaches to the proposed triple and quadruple parallel runways at Dallas/Ft. Worth Airport have been approved. Simulations of independent parallel IFR approaches to runways spaced 3,000 ft. apart using 1 mrad, 1 second update rate were conducted in FY91. Further research and development will be required before simultaneous IFR approaches at spacings below 3,400 ft. can be approved.

Specifications have been incorporated into a limited production contract which was awarded for five E-Scan systems in March 1992.

Products

- Operational requirements definition
- Automatic blunder-detection algorithms
- Validated runway separation model
- Measured performance of displays, blunder-detection algorithms, and E-scan and Mode S sensors
- Evaluation and procurement specification for production sensors or sensor modifications
- Operational procedures and guidelines

G.4.10 Multiple Runway Procedures Development

Responsible Division: ARD-100
Contact Person: Gene Wong, 202/267-3475

Purpose

To develop ATC concepts and procedures to reduce airport delays by more fully utilizing the capacity of multiple runway configurations during Instrument Meteorological Conditions (IMC).

Air traffic procedures and flight standards criteria for simultaneous dual, triple and quadruple Instrument Flight Rules (IFR) parallel approaches will be developed and validated. Requirements and techniques for improved surveillance, navigation and ATC display capabilities will be developed to support these procedures.

Studies sponsored by the FAA and the aviation industry have identified technical and operational concepts with the potential to reduce airport arrival delays by better utilizing multiple runway configurations in IMC. These concepts include the use of improved and current monitoring systems for conducting simultaneous approaches to dual, triple and quadruple parallel runways. Improved monitoring technology includes precision runway monitor (PRM) systems, as well as high resolution ATC displays with controller alert aid and Airport Surveillance Radar-9 (ASR-9). Promising concepts will be validated through ATC simulations and, in some cases, full-scale demonstrations at airports.

Multiple IFR parallel approach procedures for Dallas/Ft. Worth Airport, which has planned the addition of third and fourth parallel runways, were developed in order to gain technical and operational insights, as well as to help expedite the implementation of such procedures. This procedure was site specific and was developed based on the use of current ARTS displays and ASR-9. This is being followed by the development of national standards for triple and quadruple IFR parallel approaches based on the current ARTS display and ASR-9 capabilities.

The FAA has completed demonstrations of electronically scanned and "back-to-back" antenna PRM technologies resulting in the acceptance of simultaneous approaches to parallel runways spaced as closely as 3,400 feet. This project will conduct additional analyses and simulations to investigate the application of the combined use of improved data rate PRM technology with highly accurate navigation/landing systems, such as satellite navigation system, microwave landing system, and state-of-the-art autopilot to further reduce the spacing standards of parallel runways. The results of these studies for dual parallel runways will also provide the basis for the analysis of spacing standards for closely spaced triple runways. The final phase of the multiple runway procedures development will focus on quadruple parallel runways.

Program Milestones

In FY91, simulation evaluation of simultaneous IFR approaches to triple parallel runways spaced 5,000 feet apart, using ASR and ARTS displays, was completed. Recommended national standards of ATC procedures and runway spacing were developed. Simulations of triple parallel IFR approaches to runways spaced 4,300 feet apart using ASR-9 and high-resolution color displays with automated alerts were performed in FY92. Additional simulations to investigate the feasibility of using high-resolution color displays with automated alerts and ASR-9 to reduce dual and triple parallel runway spacing standards to 4,000 feet is scheduled in FY92. Simulations of dual and triple runways spaced 3,000 feet apart, using the PRM system, were conducted in FY92. Simulation evaluation of the use of offset localizer and PRM to reduce the dual parallel runway standard to 3,000 feet will be completed in FY93. Also in FY93, studies will be initiated to conduct research in the combined use of PRM technology and advanced navigation/landing technology for possible further reduction of runway spacing standards below 3,400 feet. Advanced navigation/landing technology includes the microwave landing system, global positioning system and state-of-the-art autopilots.

Products

- Simulation analysis of ATC procedures
- Flight procedures and system requirements for simultaneous IFR approaches to triple and quadruple parallel runways
- Technical reports on simulation results

G.4.11 Airport Surface Visual Control (Lighting)

Responsible Division: ACD-100
Contact Person: Paul H. Jones, 609/484-6713

Purpose

To provide concepts and criteria for improved lighting, marking, and signing devices. These concepts and criteria will improve airport safety by providing better guidance in low-visibility conditions.

Program Milestones

The efforts in this program will be accomplished by developing and testing improved lighting, marking, and signing devices for the ground guidance of aircraft at very low visibility conditions. New concepts for lighting and its energy sources, as well as self-contained systems requiring little or no maintenance, will be investigated. Tests of promising systems and concepts will be initially conducted at the FAA Technical Center. When necessary, improved systems will be validated by field tests at operational airports. Recommendations will be developed for incorporation of the improved lights, markings, and signs in the Advisory Circular.

In FY91, an effort was initiated to determine specifications for a lighting simulator and to further develop recommendations (in the form of a research report) for design criteria for the following visual guidance systems:

- Stop-bar system tests
- Markings for holding aircraft in low-visibility conditions
- Hold-short lighting system
- Improved taxiway exit identifier
- Improved taxiway guidance systems

Products

- Research reports and design criteria
- Lighting standards for airports

G.4.12 Development of "Land and Hold Short" Runway Warning Lights

Responsible Division: ACD-100
Contact Person: Paul H. Jones, 609/484-6713

Purpose

To develop and test a visual guidance system intended to indicate to the pilot the point at which he must stop his aircraft on rollout after landing on a runway which intersects with another active runway, thus ensuring safety and increasing capacity on airports having intersecting runways.

Program Milestones

During FY91, testing of a prototype system at Boston Logan Airport was completed. A final report on the prototype system was issued September 1991.

Products

- Specifications for a pulsing, white, in-pavement lighting system arranged as a "bar" across the landing runway

G.4.13 Development of ATC-Controlled Stop-Bar Lighting System

Responsible Division: ACD-100
Contact Person: Paul H. Jones, 609/484-6713

Purpose

To test, and evaluate prototype ICAO-modified-standard stop-bars installed at the intersections of taxiways with runways at JFK Airport.

To obtain operational, maintenance, controller workload, and human factors experience in use of stop-bars to prevent runway incursions in all visibility conditions.

To develop specifications for a standard FAA stop-bar system.

To obtain operational, maintenance and controller workload experience in the use of stop-bars to support Surface Movement Guidance and Control (SMGC) requirements for low-visibility operations.

Program Milestones

Operational testing of stop-bars at JFK was begun in FY91 and was completed in FY92. A final report on the use of stop-bars that will provide airport operators with information on system requirements and air traffic personnel with operating procedures for the use of stop-bars will be issued.

Products

- Report on the operational, maintenance and controller workload experience in the use of stop-bars for control of runway access at JFK during all visibility conditions
- Specifications for a FAA stop-bar system
- Report on the operational, maintenance and controller workload experience in the use of stop-bars for control of runway access at Seattle-Tacoma International Airport in support of SMGC low visibility operations

G.4.14 Evaluation of Airfield "Smart Power"

Responsible Division: ACD-100
Contact Person: Paul H. Jones, 609/484-6713

Purpose

To test the prototype system components of a Swedish/CAA-developed system for controlling lighting devices on airfields.

This system superimposes a coded control signal on existing power cables, providing a capability to turn individual lights on and off. Such a system could, through selective control of circuits, light only those lights needed to guide pilots along preferred routes or even sequence the lights to progressively guide pilots.

Program Milestones

The acquisition and installation of the components of a "smart power" system was completed in FY91. Testing of the system was completed in FY92. The final report (completed in February 1992) provides data to the FAA Office of Airport Standards for use in developing standards for the use of "smart power" technology.

Products

- Final report identifying potential U.S. applications of Airfield "Smart Power" Technology, evaluating the effectiveness of the applications, and evaluating the compatibility of such a system with existing and proposed U.S. equipment

G.4.15 Airport Pavement Technology

Responsible Division: ARD-200
Contact Person: Aston McLaughlin, 202/267-8694

Purpose

To reduce the costs of pavement expenditures through a systematic research program covering three areas: pavement design and evaluation, materials and construction methods, and repairs and maintenance techniques.

Airport pavement design techniques have evolved from highway design theory developed in the 1920's and extrapolated in the 1940's and 1950's for application to aviation. While this has worked reasonably well in the past, it will not accommodate the changes associated with the new generation of aircraft now on the drawing boards.

Research in pavement design and evaluation will focus on the development of a universal pavement design method that can be applied to both flexible and rigid pavements. Efforts will concentrate first on the completion and validation of the layered-elastic design method and second on more rigorous design methods, such as mechanistic analysis, to accurately model material properties. In addition, research will be conducted to develop criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions.

Research efforts in pavement materials and construction will include developing methods to specify and use new or improved materials as substitutes for conventional materials; identifying factors affecting the durability of airport pavements; developing criteria for efficient use of new construction devices, materials, and techniques, to include evaluating coal-tar mixes, roller-compacted concrete, and geotextiles and grid type materials.

Research in the area of pavement maintenance and repairs will include determining probable causes of significant distress and life-cycle costs in pavements and developing criteria and guidance for using seal-coating materials effectively to enhance pavement longevity.

Program Milestones

In FY92, efforts were initiated to validate the layered elastic theory as a part of the development of a universal pavement design methodology. A major test program was initiated to develop a sensors and instrumentation system for a long-term, comprehensive investigation of structural and environmental parameters affecting pavement performance. Studies on joint efficiency, load transfer, seal-coating procedures, and non-destructive testing were completed. A laboratory validation effort on a predictive design and analysis methodology and work on a mechanistic design methodology continued. Work on using segmented concrete in apron areas was initiated.

In FY93, the sensors and instrumentation system will be fabricated and installed at a major airport at selected locations in the runways and taxiways. Validation of the layered elastic theory for pavement design will continue. Computer software development will be initiated to graphically represent stresses and deformation using the predictive design and analysis methodology. In addition, studies will be initiated on advanced nighttime construction methods, lime-sulfate reaction, durability of asphalt mixes, and improved shoulder designs.

In FY94, the pavement design method using layered elastic theory will be fully developed, validated, and ready for application. Work on the mechanistic design method will be accelerated to develop the universal pavement design methodology. Work will continue on collecting and analyzing data that relates pavement performance with FAA design and construction standards. Criteria and methods for design, evaluation, performance, and serviceability of pavements at airports in cold regions will be completed.

Products

- Technical data for pavement design and design life, evaluation, materials, construction, maintenance, and repair
- Software and user guidelines for pavement design and analysis
- Test methods and non-destructive testing methodology

G.4.16 Wake Vortex Research

Responsible Division: ARD-200
Contact Person: Cliff Hay, 202/267-3021

Purpose

To evaluate the feasibility and benefits of reclassification of aircraft from three to four categories.

To develop a set of new, reduced wake vortex separation standards for use by ATC, starting with heavy-behind-heavy separations.

To characterize wake vortex transport and decay close to the ground and between closely spaced parallel and intersecting runways as a function of meteorological conditions.

To determine the time interval for a safe departure on the same and on intersecting runways.

To evaluate current and advanced sensor technology and develop wake vortex detection and avoidance system for automated wake-adaptive separation.

Program Milestones

In FY93, a report was published on wake vortex signatures of B757 and B767 aircraft. Analyses of data from past experiments are continuing. A report on helicopter wake vortices is near completion. Plans were completed to visit Europe this summer for a technical information exchange conference on wake vortex research.

Products

- New aircraft wake vortex separation criteria.
- Runway spacing criteria, starting with heavy-behind-heavy.
- Time-based separation criteria for departures to support terminal air traffic control automation.
- Automated wake-adaptive separation systems.

G.4.17 Visual Guidance System Simulation Capability

Responsible Division: ACD-100
Contact Person: Paul H. Jones, 609/484-6713

Purpose

To develop a visual simulation capability for use in visual guidance research and development to improve the ability to assess pilot acceptance of visual guidance changes.

Program Milestones

Determination of the present FAA B-727 simulator visual system capabilities and actual low-visibility parameters was conducted in FY92. The criteria for improved lighting in the B-727 simulator visual system will be defined and validated and desk top PC software will be investigated for use in performing lighting research in FY93.

Products

- Definition of requirements for hardware and software development for a visual flight simulator